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QUESTIONS ON HUXLEY'S LESSONS

IN

ELEMENTARY PHYSIOLOGY.

SCHOOL CLASS BOOKS
MACMILLANS

QUESTIONS

ON

HUXLEY'S LESSONS

IN

ELEMENTARY PHYSIOLOGY.

FOR THE USE OF SCHOOLS

BY

THOMAS ALCOCK, M.D.

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PREFACE.

HAVING been called upon several years since to give instruction in Physiology to a class of young people, the Questions contained in this little volume were prepared week by week as the subject was proceeded with, their purpose being to assist me in ascertaining if the sense was clearly understood. They have since been tested by frequent use, and are now offered to teachers in the hope that they may prove of similar service to them.

Through the courtesy of Professor Huxley, I was enabled at the earliest possible moment to adapt my Questions to the Second Edition

of his work, recently published, by making the necessary additions; and my best thanks are due to him for his kind consideration.

THOMAS ALCOCK.

OAKFIELD, ASHTON-ON-MERSEY,
November 6th, 1868.

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QUESTIONS

ON

HUXLEY'S

ELEMENTARY PHYSIOLOGY.

LESSON I.

A GENERAL VIEW OF THE STRUCTURE AND FUNCTIONS OF THE HUMAN BODY.

1. WHAT is Human Physiology?
2. What are the results of active life in a man: what does he do, what exhales from him, and what is the effect on his body?
3. How can these statements be proved by experiment?
4. How is the presence of carbonic acid proved by lime-water becoming milky?
5. What are the sensations felt when loss of substance of the body has taken place?
6. What are the three things necessary for the continuance of life?
7. What is the name of the compound in the food which is necessary to support life?
8. What other matters in the food are required for living with comfort?

9. What excretions leave the body as a result of its use and waste?

10. What ingredient of air is it that is required by the living body?

11. State the constantly recurring series of events which take place in the body, and are necessary to the continuance of life.

12. What are the obvious divisions of the body?

13. What are the divisions of the head?

14. What, of the trunk?

15. Describe the parts seen if the body is divided longitudinally.

16. How many bones of the vertebral column are divided by this section?

17. What is the name and nature of the partition which divides the ventral or front cavity of the trunk into two chambers, and what are the names given to these chambers?

18. What organs are contained in the abdomen?

19. What organs are contained in the thorax?

20. What name is given to the brain and spinal cord, and where are they lodged?

21. What is the essential plan of the body as shown by a longitudinal, or, still better, by a transverse section?

22. What are the differences of proportion of the anterior and posterior spaces in the head and trunk?

23. Of what parts or layers is the skin composed, and what are the characters of each layer?

24. What is mucous membrane, and where is it found?

25. What is connective tissue?

26. What is the soft red flesh of the body called, and what peculiar property does it possess?

27. How do the bones of the limbs act under the influence of the muscles?

28. Of what does bone consist, and how is it formed?

29. How many bones are ordinarily reckoned in the whole human body, and how many in each division of it?

30. In what way does the natural course of development of the skeleton interfere with a strict enumeration of the bones?

31. By what are the bones joined together?

32. What substance covers the ends of bones where they come together at a joint?

33. What is placed between the opposed surfaces of cartilage in a joint?

34. How is the body kept erect in standing?

35. What is the directing power over the muscles?

36. Where does this power originate when an action is voluntary?

37. What will be the result, with regard to his muscular power, supposing a man to live after his spinal cord is divided?

38. Where does the nervous direction originate, when muscular action in the legs results from an external stimulus applied to the feet, in the case just supposed?

39. Name the organs of special sense.

40. What are the organs called which convert food into nutriment?

41. What, those which distribute the nutriment to all parts of the body?

42. What, those which remove waste products?

43. Enumerate the organs of alimentation.

44. What are the capillaries, and from what

parts of the body are they absent; with what vessels are the blood-capillaries continuous, and by what means is the blood caused to circulate through the whole system of these vessels?

45. Where and how is nutriment received into the blood-circulating system; and how is this nutriment transferred to the tissues, while waste matters from the tissues are received into the current of the blood?

46. Name the three excretory organs.

47. In what character do these apparently different organs agree?

48. What are the proportions in which water, carbonic acid, and urea are excreted by these several organs?

49. What function have the lungs in addition to that of excretion?

50. How is the body constantly and uniformly warmed?

51. By what means are the alimentary, distributive, excretory, and combustive processes going on in the body regulated, so as to maintain a state of physiological balance?

52. What is death, in the ordinary sense of the term?

53. What two kinds of death may be distinguished?

54. Explain the nature of local death as it is constantly going on in the living body.

55. What two kinds of general death are there?

56. Name the three organs, the cessation of the functions of any of which will cause general death, and specify the one which, when mortally injured, causes death only in a secondary manner, by its influence over the other two.

57. When life ceases, what changes at once begin to take place in the dead body, and what is their final result?

58. What becomes of the separated materials of which the body was composed, and what may possibly be their further history?

LESSON II.

THE VASCULAR SYSTEM AND THE CIRCULATION.

1. Of what are the capillaries formed?
2. What is the size of the capillaries?
3. What is their general arrangement, and what differences in their character are seen in different tissues?
4. From what parts are they absent?
5. What are tissues called which are without capillaries?
6. What two different fluids are found in different capillary tubes in the body?
7. Into what vessels are the blood-capillaries continued?
8. What is the difference in structure between the small arteries and veins, and the capillaries; and what is the consequent difference in their function?
9. Describe the structure of a small artery.
10. What is the function of its muscular coat, and by what is this function regulated?
11. Describe the structure of a large artery.
12. What is the structure of a large vein?
13. State the differences in the structure of their walls between a large artery and a large vein.

14. What is the nature and use of the valves in veins?

15. In what parts of the body are they chiefly found?

16. How can the presence of these valves be shown in the living body?

17. What is the character of the lymphatic capillaries in which they differ from blood-capillaries?

18. Describe a lymphatic trunk, and say in what it differs from a vein.

19. What is the structure of a lymphatic gland?

20. What is the thoracic duct, and where is it situated?

21. Where does the thoracic duct empty itself?

22. What are the lymphatics of the intestines called?

23. Where do they empty themselves?

24. From what parts do the veins come which join to form the superior and the inferior vena cava?

25. What are the arteries which do not branch off from the aorta?

26. From which chamber of the heart does the aorta arise?

27. From which chamber of the heart does the pulmonary artery arise?

28. Into what chamber of the heart do the veins of the lungs empty themselves?

29. What are the coronary arteries and veins; where do the arteries arise and the veins empty themselves?

30. Which abdominal viscera have veins taking a different course from those of other parts of the body?

31. What course do these veins take, and, by uniting, what large vessel do they form?

32. What is the further course of the blood in this system of vessels until it finally reaches the inferior vena cava?

33. What is the size of the heart, and its situation and position in the chest?

34. What is the pericardium, and what fluid does it contain?

35. Into what chambers is the heart divided, and what are they called?

36. What is the usual capacity of each of these chambers?

37. What is the relative thickness of the walls of the several chambers?

38. What kind of muscular fibres are those forming the walls of the heart?

39. What is the lining of the heart called?

40. What is the valve called which closes the auriculo-ventricular aperture on the right side?

41. What is the valve called which closes the auriculo-ventricular aperture on the left side?

42. Of what different parts are these valves formed, and what is the arrangement and use of the several parts?

43. What are the semilunar valves, where are they placed, and what is their use?

44. What are the rhythmical contractions and dilatations of the heart called?

45. Describe the order in which the contractions take place.

46. What is there to hinder the blood from the right auricle when it contracts flowing back into the vena cava?

47. What prevents the blood from flowing back

into the right auricle when the right ventricle contracts?

48. What is the use and action of the chordæ tendineæ and columnæ carneæ of the auriculo-ventricular valves?

49. Name the several sources of resistance which the left ventricle has to overcome when it forces its contents through the semilunar valves.

50. How is room found in the full arteries for the sudden addition of the blood forced in by the contraction of the left ventricle?

51. What happens in the arteries in consequence of the systole of the left ventricle; and when the systole is over, what effects are produced by the action of the walls of the arteries?

52. What is the cause of the beating of the heart which may be felt between the fifth and sixth ribs on the left side?

53. What kind of sounds may be heard by listening to the heart against the walls of the chest?

54. What is the pulse, and what is it caused by?

55. In what manner does the blood flow from a cut artery, and why?

56. What several causes unite to equalize the flow of blood in the capillaries, so that the intermittent impulse of the heart is lost?

57. State the course of the circulation of the blood, beginning at the right auricle, and naming the several chambers and vessels through which the blood successively passes.

58. Describe the vena portæ.

59. What course is the shortest by which blood can leave the left ventricle and return to the right auricle?

60. Describe the longest course the blood can take.

61. If two particles of nutrient matter enter a villus of the intestine, and pass the one into the vein of the villus, and the other into the lacteal, what course will each take to arrive at the right auricle of the heart?

62. What is the cause of blushing, and of turning pale with fear?

63. How can it be shown by experiment that the sympathetic nerve regulates the supply of blood through the small arteries to the capillaries?

64. What is the practical importance of this local control over the blood-vascular system?

65. What different nerves govern the actions of the heart?

66. What nerves regulate the rhythmical contractions of the heart?

67. What nerve probably causes increased rapidity of the heart's action?

68. When the heart suddenly stops from mental shock, what nerve is the cause?

69. What experiment on a frog has been made to prove that excitement of the pneumogastric nerve stops the heart's action?

70. In what cases can you observe the actual circulation of the blood in a living body?

LESSON III.

THE BLOOD AND LYMPH.

1. WHAT easy plan may be adopted for obtaining small quantities of fresh blood for microscopical examination?

2. How are you directed to treat three drops of blood so obtained?

3. What is the appearance, when moderately magnified, of a drop of blood which has been spread in a thin layer by being covered with glass?

4. What are the particles in the blood called, and what name is given to the colourless fluid?

5. In what state will a drop of blood be found which has been simply allowed to stand a few minutes undisturbed, and covered with an inverted tumbler to keep it from drying?

6. What is this setting or solidifying of the blood called?

7. In what state will the drop of blood be found to which a little salt was added?

8. What facts are ascertained by these observations on the three drops of blood?

9. Describe the blood-corpuscles as seen under the microscope with a high magnifying power.

10. What is the size of a red blood-corpuscle,

and how many of them will lie on the space of one square inch?

11. What is the name of the semi-fluid or quite fluid matter contained within the red corpuscles, and into what two substances may this be resolved?

12. What is the effect on the red blood disks of increasing the density of the plasma in which they float, by dissolving sugar or salt in it?

13. What is the effect on them of diluting the plasma with water?

14. What corresponding effects are produced by carbonic acid and oxygen?

15. What is the size of the colourless corpuscles of the blood?

16. What is the most remarkable character to be observed in a microscopical examination of the colourless corpuscles of fresh blood?

17. What is the structure of a colourless corpuscle, and what means must be taken in order that this structure may be seen under the microscope?

18. What living organism found in stagnant water do the colourless corpuscles resemble?

19. Whence are the red blood-corpuscles derived, and what are they?

20. What is the probable origin of the colourless blood-corpuscles?

21. What kind of corpuscles are found in the blood of those invertebrate animals which have any?

22. What kind of corpuscles are found in the blood of the lancelet, and in that of the very young embryos of all vertebrate animals?

23. What is an embryo?

24. What kind of corpuscles are found in the blood of vertebrated animals which lay eggs?

25. What different kinds of vertebrated animals have their young born from eggs?

26. What kinds of corpuscles are found in the blood of Mammalia?

27. What is the peculiarity in the blood-corpuscles of the camel?

28. What animal has the smallest red blood-corpuscles?

29. In what vertebrata are the largest red blood-corpuscles found?

30. When the blood is dying—which it does in a few minutes after being drawn from the body—what happens with the colourless, and what with the red corpuscles?

31. What name is given to the contents of the red corpuscles, and by what treatment may they be made to crystallize?

32. What is the substance called which forms the extremely delicate fibres seen under the microscope in blood which has coagulated?

33. If a pint of blood be drawn into a basin, as when a person is bled, and be allowed to stand for a quarter of an hour, what appearance will it then present?

34. What is the clear yellow liquid called, and what the red semi-solid mass?

35. Of what does the crassamentum consist?

36. What is the appearance called the buffy coat in coagulated blood, and what is it caused by?

37. How can fibrin be obtained in a pure state from fresh-drawn blood?

38. By what conditions is the coagulation of the blood hastened, retarded, or temporarily prevented?

39. By the interaction of what two substances contained in the blood is its coagulation and the formation of fibrin caused, and how may these substances be obtained pure and in a solid state?

40. What is the specific gravity of the blood?

41. What is the proportion of colourless corpuscles to red corpuscles in the blood?

42. What is the temperature of the blood in the body?

43. What is the proportion of dry solids to water in one hundred parts of blood, and of what do these solids consist?

44. What is the proportion of fibrin in one thousand parts of blood?

45. What gases are contained in the blood, and in what proportions?

46. What ingredient of the blood has the power of holding the large proportion of oxygen which that fluid contains?

47. What metal is found in the red corpuscles?

48. What differences are found in the blood according to age, sex, and diet?

49. What is the total quantity of blood in the body?

50. What is the function of the blood, and on what does its vivifying influence depend?

51. What is transfusion, what is its effect, and with what restrictions may it be used with advantage?

52. What is the nature of lymph as compared with blood, and from what sources is it derived?

LESSON IV.

RESPIRATION.

1. To what various circumstances does the blood owe its complex nature?

2. In what part of the circulation does the blood undergo its most remarkable and important changes?

3. What change, evident to the eye, takes place in blood passing from arteries through capillaries into veins?

4. What chemical differences distinguish arterial from venous blood, and what is the one essential difference between the two?

5. How can it be shown experimentally that the proportions of oxygen and of carbonic acid contained in blood really make the difference in the appearance of arterial and of venous blood?

6. State what is known of the nature of the physico-chemical processes involved in the interchange of carbonic acid and oxygen between the blood and the air in the lungs.

7. What difference is there between oxygen and carbonic acid with respect to their solubility in water?

8. What two reasons can be given for the change of colour when carbonic acid replaces oxygen, or oxygen carbonic acid in the blood?

9. Where, in the course of the circulation, does the change from venous to arterial blood take place?

10. What are the special characters of the lung capillaries, and what are the resulting advantages?

11. What difference is there between the gaseous constituents of arterial and of venous blood?

12. What is the essence of the respiratory process, and what is the simple structure necessary for its performance?

13. Why is a complicated machinery required?

14. Give a general description of the parts through which the air passes on its way from the mouth or nose into the lungs.

15. What provisions are made for closing the glottis?

16. Describe the cartilaginous hoops of the trachea and of the bronchi, and state their use.

17. What is the structure of the walls of the smallest bronchial tubes?

18. In what do the smallest bronchial tubes terminate?

19. What is the size and character of the air-cells of the lung?

20. How many respirations are taken in a minute by an adult man breathing calmly in a sitting position?

21. What are the separate acts of respiration, and in what order are they performed?

22. How much air is taken in at each inspiration?

23. What is the temperature of expired air?

24. What is its condition with regard to moisture?

25. What quantities of oxygen and of carbonic

acid are contained in 10,000 parts of ordinary air, and in 10,000 parts of air that has been breathed?

26. What matters come from the body with the expired air in addition to carbonic acid and moisture?

27. How much per cent., speaking roughly, of oxygen and of carbonic acid is exchanged in respiration, and which gas is slightly in excess of the other?

28. How many cubic feet of air pass through the lungs in twenty-four hours, supposing there are thirteen or fourteen inspirations a minute, each of thirty cubic inches of air?

29. How much oxygen is taken in and carbonic acid given out during this time?

30. What weight of charcoal would represent the quantity of carbon given out by the body in twenty-four hours?

31. What is the average quantity of water given off by the lungs in the same time?

32. What are the two mechanical means by which the respiratory movements are effected?

33. Describe the form and general structure of the thorax.

34. What is the serous membrane covering the lungs and lining the walls of the thorax called?

35. What causes the lungs to shrink and collapse when an opening is made into the chest?

36. What keeps them in contact with the walls of the chest before an opening is made?

37. What amount of force is exerted on each square inch of surface of the lung by the elastic tissue it contains?

38. What is the character of the epithelium of the bronchial tubes, and what is its use?

39. What are the names of the two sets of muscles placed between each successive pair of ribs, and what is the action of each set?

40. Describe a simple apparatus by which the action of the intercostals may be illustrated and explained.

41. What is the diaphragm, and of what is it composed?

42. What is the result of contraction of its muscular part, and what effect is produced upon the capacity of the chest?

43. Either the intercostals or the diaphragm may separately increase or diminish the capacity of the chest; what are the names given to these two kinds of respiration?

44. Describe diaphragmatic respiration.

45. Describe costal respiration.

46. What accessory agencies come into play when respiration becomes laboured from any cause?

47. What is sighing, snifting, coughing, sneezing?

48. What important difference is there between the chest and lungs and a pair of bellows, with which their action may be compared?

49. What is the air which cannot be got out of the chest by forced expiration called?

50. What is its quantity?

51. What is the additional air which remains after an ordinary expiration called?

52. What are the twenty or thirty cubic inches of air taken in at each ordinary inspiration called?

53. Supposing the lungs to contain 100 cubic inches of residual air, 100 cubic inches of supplemental air, and 30 cubic inches as the result of an ordinary inspiration, making 230 cubic inches in all,

how much more air may be taken in by the deepest possible inspiration, and what is this additional air called?

54. There being usually no complemental air, and the residual air being always, and the supplemental air generally, stationary in the chest, the tidal air alone brings oxygen into the system and carries off carbonic acid; how is the exchange of these gases between the blood and the tidal air effected?

55. What reasons have you for knowing that the stationary air in the chest contains a great excess of carbonic acid?

56. What part of the cerebro-spinal axis controls the action of the glottis; and, in case of irritation of the mucous membrane of this part, what is the usual result of the muscular contractions which it excites?

57. What is the use of the muscular fibres in the walls of the smaller bronchial tubes, and with what part of the blood-circulating system do they correspond?

58. What are the respiratory sounds, where are they heard, and by what are they caused?

59. Why are the heart and great blood-vessels in the chest subjected to less pressure than the blood-vessels of the rest of the body during inspiration?

60. What is the effect of this diminished pressure in the chest upon the blood returning to the heart by the great veins?

61. What is the condition of the blood in the large arteries which causes it to be uninfluenced by this diminution of atmospheric pressure in the chest?

62. What is the effect of expiration upon the flow of blood towards the heart in the large veins?

63. What movement of the brain may be seen by exposing it in a living animal, and with what does this movement correspond?

64. What effect may be produced on the heart by a strong expiratory or inspiratory effort, the mouth and nose being kept closed; and what explanation can be given in the latter case?

65. What effect is produced on the respiratory process by cold, food, and exercise?

66. What difference in the activity of the respiratory process is observed at different ages?

67. At what time in the twenty-four hours is the excretion of carbonic acid least?

68. What difference has been observed in the relative quantities of the oxygen taken in by respiration, and of that given out again (in combination with carbon as carbonic acid) at different times of the twenty-four hours?

69. Do carnivorous animals or herbivorous take in more oxygen in proportion to the carbonic acid excreted?

70. Under what circumstances does a man suffer from asphyxia, and in what manner is he affected?

71. What two distinct influences are at once producing death by asphyxia?

72. By what experiment may you watch the effect of oxygen starvation without the complication of carbonic acid poisoning?

73. Under what conditions may air containing a very large proportion of carbonic acid be breathed without serious ill effects?

74. What happens within the body as the consequence of asphyxia?

75. In what way do sulphuretted hydrogen and carbonic oxide produce their injurious effects on the blood?

76. How may asphyxia be produced without in any way stopping respiration?

77. What proportion of carbonic acid in the air, supposing the oxygen to be diminished in the same measure, will produce asphyxia?

78. What symptoms arise from breathing an atmosphere deprived of some of its oxygen and containing too much carbonic acid, though not nearly impure enough to cause asphyxia?

79. How many cubic feet of air should each man have to himself in a sleeping-chamber in order to keep his blood in a fair state of purity by respiration?

LESSON V.

THE SOURCES OF LOSS AND OF GAIN TO THE BLOOD.

1. WHAT three distinct sets of excretory organs eliminate waste matters from the blood, and what are the substances excreted by them?

2. What is the source of loss, and what of gain to the blood in its passage through the systemic capillaries?

3. At what parts of the body does the blood lose heat?

4. What is the source of loss to the blood in its passage through the liver, and is this loss permanent or tempo a ry?

5. What does the blood lose, and what does it gain, in its passage through the lung capillaries?

6. What parts of the body are those in which there is an intermittent or occasional loss to the blood?

7. What are the intermittent sources of gain to the blood?

8. What is the source of the heat of the blood?

9. Describe the kidneys, their number, form, situation, and connections.

10. What provision is made for the occasional

discharge of the urine, which is being constantly excreted?

11. What is the chemical constitution of the renal excretion?

12. What is the average quantity of urine excreted in twenty-four hours, and what quantity of urea and of uric acid does this contain?

13. What saline matters and what gases are contained in the urine?

14. What is the average specific gravity of urine?

15. What relation does the constitution of the urine bear to that of the blood from which it is, as it were, filtered by the kidneys?

16. What do you see on making a longitudinal section of a kidney?

17. Of what structures is the substance of the kidney made up, and what difference in their arrangement causes the different appearance of the medullary and the cortical portions?

18. Describe a Malpighian capsule.

19. What is the further distribution of the small vein which comes from the Malpighian capsule?

20. What is the function of the glomerulus or bunch of looped capillaries in the Malpighian capsule, as indicated by the mechanical arrangement of the parts?

21. What kind of blood is supplied to the kidneys, and whence is it derived?

22. What part of the blood vascular system contains the purest blood in the body?

23. What is the effect of irritation of the nerves supplying the kidneys?

24. How can you prove that the skin is a continual source of loss to the blood?

25. What do you find in the india-rubber bag as a result of the experiment just mentioned?

26. What is the evaporation from the surface of the skin as it usually takes place called?

27. What conditions affect the quantity of perspiration?

28. How much water is estimated to be given off from the skin compared with the quantity given off by the lungs in the same time?

29. What is the proportion of carbonic acid excreted by the skin compared with that excreted by the lungs?

30. Describe the structure of the sweat glands.

31. Explain their action and use.

32. How many of these glands are there in a square inch of the skin of the back?

33. How many in a square inch of the skin of the palm of the hand?

34. How many is the whole surface of the body estimated to possess?

35. How can it be shown by experiment that the sweat-glands are under the influence of the nervous system?

36. What is the condition of the blood on leaving the skin after passing through its capillaries?

37. What is the essential plan of structure in which the three great excreting organs agree, and what two of them approach so nearly in function that they may to some small extent do each other's work?

38. In what respect is the liver a source of loss to the blood; and in what of gain?

39. Describe the liver, its weight, colour, and position in the body.

40. What vessels enter the liver, and what pass out from it?

41. What is the use of the gall-bladder?

42. Where and how do the branches of the hepatic artery and portal vein ultimately end?

43. What is the size of the lobules of the liver?

44. Where does the hepatic vein commence in the substance of the liver?

45. Where does the hepatic duct commence?

46. Of what is the substance of the lobules of the liver composed?

47. What is the size and character of a liver-cell, and what is the use or function of these cells?

48. How can you ascertain what the active powers of the liver-cells are?

49. What quantity of bile is believed to be secreted in twenty-four hours?

50. What sensible qualities does the bile possess?

51. How much solid matter does it contain?

52. Of what three substances does this solid matter consist, not including salines?

53. What is the nature and chemical composition of bilin?

54. Into what two acids may it be separated by chemical agency?

55. With what alkali are these acids combined in the bile?

56. Which of the solid matters of the bile can be discovered in the blood?

57. Since bilin does not exist in the blood, how does it come to be in the bile, and what eventually becomes of it?

58. What does the blood gain in its passage through the capillaries of the lungs and skin?

59. Mention the special characters of that blood which leaves the liver by the hepatic vein.

60. What is liver-sugar called?

61. From what is it formed, and in what manner?

62. Name the several "ductless glands"?

63. Describe the structure of the spleen.

64. What is the character of the blood which leaves the spleen by the splenic vein?

65. What three conditions cause the temperature of the body to be the same under all varieties of external circumstances?

66. What is it that generates heat in the body; and in what processes, and where is it evolved?

67. How is the heat which is produced in parts of the body, rapidly distributed to the whole; and if a warming apparatus were constructed to imitate the plan of that in the body, what modification of the usual arrangement would require to be made?

68. How is the temperature of the body moderated, by what arrangements is a fixed temperature preserved, and how might this be accomplished in the artificial warming apparatus already supposed?

69. Explain the means by which the amount of exudation from the capillaries of the skin, and the consequent evaporation from the surface, are adjusted to the external temperature.

70. How is it that a man can remain with impunity for a considerable time in a heated oven?

71. What are the intermittently active sources of loss to the blood?

72. Give a general description of the structure of simple and of more complicated glands.

73. What is the chief intermittent source of gain of waste products to the blood?

74. What facts show that a large proportion of the waste of muscle consists of carbonic acid?

LESSON VI.

THE FUNCTION OF ALIMENTATION.

1. WHAT is the chief source of gain to the blood?

2. What is the whole process of reducing the food to the state of nutriment fit to enter the blood called?

3. What daily weight of dry solid material has been found necessary to sustain a man of average size and activity?

4. What daily weight of oxygen gas is absorbed by the lungs?

5. What daily weight of dry solid matter leaves the alimentary canal?

6. What are the four kinds of substance which are used as food?

7. What is the chemical composition of proteids?

8. Name the different substances included under this head.

9. What is the chemical composition of fats?

10. What, of amyloids?

11. Name the substances included under this head.

12. What are these three kinds of food (proteids, fats, and amyloids) called, and why?

13. What are mineral food stuffs?

14. Which of these substances is most necessary to support life?

15. What fact in the working of the bodily frame shows the necessity of continual introduction of fresh nitrogenous material?

16. What are the substances finally resulting from the oxidation of protein?

17. What would you call the wasting which would immediately commence if no food were taken but amyloids and fats?

18. Under what circumstances does a sheep become a carnivorous animal?

19. Though proteids are the essential parts of our food, why is it that it would be disadvantageous to confine our diet to them?

20. What weight of carbon and what of nitrogen is eliminated daily by a man?

21. How much fatless meat would a man have to eat daily to get from it the necessary quantity of carbon?

22. How much fatless meat will give him all the nitrogen he requires?

23. Explain what would be the physiological disadvantage of a purely protein diet?

24. If a pound of flesh is taken daily to supply the necessary nitrogen, how much carbon will need to be supplied by fats and amyloids?

25. How much fat or sugar will supply the required quantity?

26. What are the proper quantities and proportions of flesh and bread for daily consumption?

27. In what state does all the oxygen taken in by the lungs leave the body?

28. Where are the amyloids and fats probably acted on by it?

29. What is the chief source of heat in the body?

30. What may proteids and amyloid foods be called according to their use in the body, and why is their distinction into heat-producers and tissue-formers incorrect?

31. What is the purpose of the processes which go on in the alimentary canal?

32. Describe the cavity of the mouth.

33. What is the chamber called which is behind the partition formed by the velum and pillars of the fauces?

34. Describe the pharynx.

35. What are the six openings in the front part of the pharynx?

36. What are the glands called which beset the mucous membrane of the mouth and pharynx?

37. Name the three pairs of salivary glands.

38. Describe their situation.

39. What is the special action of the saliva on the food, and on what does this action depend?

40. How many teeth form a full set in an adult?

41. What are the two portions of which a tooth is composed?

42. What are the two teeth on each side of the middle line above and below called, and what is their form and use?

43. What is the next tooth on each side above and below called, and what is its form?

44. What is the character of the bicuspid teeth, and how many are there on each side in each jaw?

45. Describe the molar teeth.

46. What is the action of the muscles attached to the lower jaw?

47. What is the substance called which forms the surface of the crowns of the teeth, and what is its character?

48. By what means is the food returned between the teeth during mastication, when it escapes to either side from between them?

49. How is the masticated food conveyed from the mouth to the stomach?

50. What are the processes of dividing the food with the teeth, mixing it with saliva, and swallowing it, respectively called; and what changes does it undergo as the result of these processes?

51. Of what structures is the stomach composed?

52. What is the enlargement at its left end called?

53. What is the opening of the gullet into the stomach called?

54. What is the pylorus, and where is it placed?

55. What are the glands called which throw out the gastric juice?

56. Where are they situated?

57. On the presence of what acids does the acidity of the gastric juice depend?

58. What is the nature of that constituent of the gastric juice which is called pepsin?

59. By what means does the food in the stomach become thoroughly mixed with the gastric juice?

60. How can you ascertain by experiment the solvent powers of the gastric juice?

61. What is the proteid solution formed by the action of the gastric juice called?

62. Is pepsin absolutely necessary to effect the solution of proteids?

63. What is the advantage derived from the presence of pepsin?

64. To what state is the food reduced by the movements of the stomach and the action of the gastric juice, and what name is given to it in this state?

65. What fluid constituents of the chyme are at once disposed of before that mixture leaves the stomach?

66. How and by what are these fluids taken into the system?

67. When the chyme passes the pylorus, into what does it enter?

68. Into what two principal parts is the whole length of the intestine divided?

69. What are the names given to the parts into which the small intestine is artificially divided?

70. What is the position of the duodenum, and with what organ is it in relation?

71. What is the name of the valve placed where the ileum opens into the large intestine?

72. What is the dilatation or sac at the commencement of the large intestine called?

73. What is the position of the cæcum in the body?

74. What is the name given to the chief part of the large intestine, and what divisions of it are named according to the directions they take in the body?

75. What names have been given to the numerous small glands with which the whole mucous membrane of the intestine is provided?

76. What are the valvulæ conniventes of the small intestines?

77. Describe the villi of the small intestine, their appearance, and what they contain.

78. Describe the peculiarities of structure of the large intestine.

79. Into what large blood-vessel do the veins of the intestines empty themselves?

80. What is the arrangement of the muscular fibres of the small intestine, and what is their mode of action in propelling their contents downwards?

81. Where does the common duct of the liver and pancreas enter the intestine, and what is the form of its orifice?

82. Into what is the chyme converted by its mixture with the bile and pancreatic juice?

83. What are the chemical differences between the chyme and the chyle?

84. To what is the conversion of starch in the chyle into sugar due?

85. How does the fatty matter of the chyle gain admission into the circulating vessels of the body?

86. Which set of vessels of the villi—the capillary blood-vessels, or the lacteals—appear to be most active in absorbing the ingredients of the chyle, and why?

87. What is supposed to be the function of the cæcum?

LESSON VII.

MOTION AND LOCOMOTION.

1. WHAT is the source of the active powers of the living organism?
2. By what do these active powers chiefly manifest themselves?
3. What are the two kinds of organs which produce motion in the human body?
4. What are cilia?
5. Upon what does the movement of a cilium appear to depend?
6. What is the character of the united action of the cilia placed on a surface of membrane, and what effect does it produce?
7. Where are these cilia chiefly found in the human body?
8. Describe a muscle.
9. What is the power which a muscle has of shortening in length called, and what is the effect of its action?
10. What is the cause of *rigor mortis*, and what particulars have been observed respecting it?
11. Into what two groups may muscles be divided?
12. Give examples of hollow muscles.
13. What is the character of the muscular fibres of the heart?

14. Describe the muscles of the iris, and explain their action.

15. What is the character of the muscular fibres of the alimentary canal, and what is their arrangement?

16. What is the mode of action of the muscular layers of the alimentary canal, and what is its effect?

17. What structures form the rigid levers to which most of the muscles of the body are attached?

18. What is the arrangement of the osseous tissue in bones which are used as levers?

19. What form and structure has the end of a bone when it is joined to another bone, so as to be moveable as a lever?

20. What is a lever, how many kinds are there, and how are they distinguished?

21. What is a lever of the first order?

22. What, of the second?

23. What, of the third?

24. Give examples in the human body of levers of the first order.

25. Give examples in the human body of levers of the second order.

26. Give examples of the third order.

27. Give an example of a joint which acts as each of the three kinds of levers according to circumstances.

28. What is the nature and use of joints?

29. Into what two classes may joints be divided?

30. What is the arrangement of the parts in an imperfect joint, and what amount of motion is allowed?

31. Give examples of imperfect joints.

32. Describe a perfect joint.

33. What different shapes are taken by articular cartilages?

34. How are the extent and direction of the movements of a joint limited?

35. What is a ball-and-socket joint, and what form of it admits of the greatest amount of motion?

36. What two kinds of hinge-joint are there?

37. Give a good example of a single hinge-joint in the human body, and explain the nature of this kind of joint.

38. What is the form of the articulating surfaces in a double hinge-joint, and what example of it is there in the human body?

39. What is a pivot-joint?

40. Give a good example of this joint in the human skeleton.

41. What is the nature of the joint in the forearm by which the hand can be rotated?

42. What position of the hand is called supination, and what pronation?

43. Name the two bones of the forearm.

44. Which bone with the humerus forms the elbow-joint?

45. What kind of joint is formed by the radius at the elbow?

46. What are the relative positions of the radius and ulna in supination, and what in pronation?

47. What kind of ligament keeps the bones together in a ball-and-socket joint?

48. What is the arrangement of the ligaments in hinge-joints?

49. What is the position and arrangement of crucial ligaments, and in what joint are they found?

50. What is the character and name of the ligament placed within the hip-joint?

51. Between what bones are the check ligaments placed which are found at the upper part of the neck, and what is their use?

52. What cause, besides the connecting ligaments, is there for the bones of the hip-joint keeping in place, and how can it be shown that this cause operates?

53. What names are given to the different kinds of movement of which bones are capable by the use of their connecting joints, and what is the character of each kind of movement?

54. In what positions are the muscles placed to move a pure hinge-joint, such as that of the elbow, and how do they act?

55. How is circumduction of the moveable bone of a ball-and-socket joint effected?

56. Which is the origin and which the insertion of a muscle?

57. What generally intervenes between a muscle and the bone to which it is attached?

58. In what way are tendons guarded when they move over hard surfaces?

59. Give an example of a muscle the action of which is not in a direct line from its origin to its insertion.

60. What is a digastric muscle, and what remarkable example of a muscle of this kind can you give?

61. In walking, if the right foot is advanced a step, the left foot still resting on the ground, how is the body propelled forwards?

62. When the whole weight rests on the right foot, how is the left advanced for another step?

63. Why do short-legged people naturally step quicker than long-legged ones?

64. How is the body propelled in running?

65. What are the conditions necessary for the production of the voice?

66. Describe the vocal chords.

67. To what are they attached at their two ends?

68. What is the form of the opening of the glottis in a quiescent state?

69. Describe the thyroid cartilage.

70. What is the cricoid cartilage, and what is its form?

71. What kind of movement has the thyroid upon the cricoid cartilage?

72. To what are the bases of the arytenoid cartilages articulated?

73. What is the effect of contraction of the posterior arytenoid muscles?

74. What is the effect of contraction of the thyro-arytenoid muscles?

75. What, of the crico-thyroid?

76. Which of these two pairs of muscles produces a low, and which a high note, and why?

77. On what does the range of the voice, and on what does accuracy of singing, depend?

78. On what does the quality of the voice depend, as to whether it is base, treble, &c.?

79. What is speech?

80. What is whispering?

81. How is the modulation of the voice into speech effected?

82. Which consonants can be sounded without interrupting the current of expired air?

83. Which consonants are formed by blocking

the current of air through the mouth allowing it free passage through the nose, and what difference in the mode of stoppage is there between them?

84. How are the letters B P, T D, and K and G hard, produced?

85. To what extent is the tongue necessary for speech?

LESSON VIII.

SENSATIONS AND SENSORY ORGANS.

1. WHAT is the immediate cause of the contraction of muscular fibre?

2. If you trace back the impression along the motor or efferent nerve, through what other parts of the nervous system do you find it to be conveyed, and by what is it usually originated?

3. What is the influence applied to the ends of the afferent nerves called?

4. Explain what is meant by reflex action.

5. What besides a reflex action may be caused by a stimulus applied to afferent nerves?

6. How is the feeling of warmth or of cold in the surface of the body produced?

7. What besides sensations are classed under the common head of consciousness?

8. Mention some sensations which are vague and undefinable.

9. What is the probable cause of such sensations?

10. How would you describe these sensations with regard to the indefinite kind of information they convey to us?

11. What is the muscular sense?

12. How can you show by experiment that it is

quite distinct from the feeling of contact and of pressure?

13. Explain why it is to be regarded as a sense, though it is incapable of being exactly localised.

14. What senses are those, the feelings arising from which are caused by stimuli applied to definite parts of the body and are referred to those parts, but the stimuli producing them are very various in their origin?

15. What senses are those, the feeling arising from which originates in each case from a single kind of stimulus applied to a very specially modified part of the surface of the body?

16. What are the two physical agents which alone act as stimuli to these two senses respectively?

17. Into what four groups then may sensations be divided?

18. What parts of the body possess the sense of touch?

19. What is the structure of surfaces having this sense?

20. What peculiarity of structure is there in those parts of the skin which have a delicate sense of touch?

21. What name is given to the oval enlargements of the neurilemma of the papillæ on the tips of the fingers and the point of the tongue?

22. In the sense of touch, what structure acts as the intermediator between the nerve and the physical agent?

23. What is the result of application of a physical agent if the epidermis or epithelium is removed?

24. How near together may the points of com-

passes be when applied to the tip of the finger, and yet give the impression of two points?

25. How near together may they be, and give a double impression to the tip of the tongue?

26. How far apart may the points be, and yet give only one impression when applied to the back?

27. How can you show that the sensation of heat and cold is relative?

28. By what examples can you show that some parts of the body appreciate degrees of temperature with more delicacy than others?

29. What and where is the organ of taste?

30. What is the general structure of the mucous membrane of the tongue?

31. What are the form and name of the papillæ near the tip?

32. What are the larger papillæ with broad ends and narrow bases called?

33. What are the structure and arrangement of the large papillæ towards the root of the tongue, and what are they called?

34. What two nerves supply the papillæ of the tongue?

35. Which nerve chiefly supplies the back of the tongue and the adjacent palate?

36. In what part does the sense of taste chiefly reside?

37. What is the organ of smell, and in what does its surface differ from the ordinary mucous membrane of the nasal cavities?

38. Describe the nasal chambers.

39. What is the cribriform plate?

40. What is the character and position of the turbinal bones?

41. What difference is there between the mucous membrane covering the upper and middle turbinal bones, and that covering the inferior turbinal bones?

42. How do we assist the access of air to the organ of smell when we wish to get the full benefit of this sense?

43. What two parts constitute the essential organ of hearing, and where are they lodged?

44. What is the general character of these two parts; of what are they composed, and how do they act in producing the sensations of sound?

45. What name is given to the minute calcareous particles found in the fluid of the membranous labyrinth?

46. What is the character of the epithelium of the labyrinth causing the impression of vibrations to be readily conveyed to the subjacent auditory nerves?

47. What are the fibres of Corti, and where are they found?

48. Of what parts does the membranous labyrinth consist?

49. Upon what parts of the walls of it are the nerves distributed?

50. What is the name of the fluid which fills the membranous labyrinth?

51. What, of the fluid which separates it from the walls of the bony chambers in which it is lodged?

52. Describe the scala media of the cochlea.

53. What two passages are formed by its position in the cochlea?

54. Where do the fibres of the auditory nerve enter the scala media?

55. Describe the arrangement and connections of the fibres of Corti in the scala media.

56. What names are given to the several parts of the bony chamber which lodges the membranous labyrinth and the scala media, and in what bone are they situated?

57. Why is the scala vestibuli so called?

58. What is the opening covered by membrane placed between the scala tympani and the tympanum called?

59. What is the name of the opening covered by membrane between the vestibule and the tympanum?

60. What small bone fills the central part of the fenestra ovalis?

61. What separates the tympanum from the external meatus?

62. What communication is there between the tympanum and the external air?

63. What other bones besides the stapes form the chain of auditory ossicles in the tympanum?

64. Describe their form and arrangement.

65. When the tympanic membrane vibrates, what happens to the auditory ossicles, and what effect is produced on the inner parts of the ear?

66. What two muscles are situated in the tympanum, and what is the effect of their action?

67. What is the concha?

68. In what state must a body be in order to originate a sound?

69. How are sounds conveyed to the ear?

70. In what other way besides through the ossicles are the vibrations of the tympanic membrane communicated to the labyrinth?

71. In what two ways may vibrations be set up in a solid body?

72. Which of the two kinds of vibrations appear, in the case of the ossicles, to be the efficient conductor of sound to the labyrinth?

73. What reasons can be given for the conclusion that this is the case?

74. What fluid first receives the vibrations from the stapes at the fenestra ovalis?

75. By what means are they further communicated as impulses to the auditory nerves?

76. What is probably the function of the membranous labyrinth in distinguishing the character of sounds?

77. What is believed to be the special function of the cochlea, and what structures in the scala media are the instruments of this function?

78. Explain and illustrate the manner in which the fibres of Corti are believed to act in giving the necessary impulses for distinct musical sounds.

79. What is the cause of singing in the ears, or musical spectra?

80. What is the duty of the muscles of the tympanum?

81. What is the function of the Eustachian tube?

LESSON IX.

THE ORGAN OF SIGHT.

1. In studying the sense of sight, what three separate parts of the subject require consideration?

2. What is the delicate structure called in which the optic nerve terminates, and what is its function?

3. At what part of the globe of the eye does the optic nerve enter?

4. Describe the retina as it is seen on dividing the globe of the eye into an anterior and posterior half.

5. Describe the nervous elements of the retina as seen under the microscope in a thin vertical section of any part of it, except the yellow spot and the entrance of the optic nerve.

6. What are the limits of the framework of connective tissue which supports the nervous elements of the retina?

7. What is the situation in the retina of the fibres of the optic nerve, and of the blood-vessels which enter with it?

8. What is seen in a vertical section of the part where the optic nerve enters?

9. What, in a section of the yellow spot?

10. What is the special property and use of the retina?

11. Where is the sensation of light produced, and how can this be proved?

12. How can you prove that the retina at the point of entrance of the optic nerve is absolutely blind?

13. For what length of time does an instantaneous flash of light leave an impression on the retina?

14. How do you explain the fact that the point of a lighted stick turned rapidly round appears as a circle of flame?

15. If you look steadily for some little time at a bright object, and then turn the eye to a moderately lighted surface, as a sheet of paper, what do you see, and why?

16. If you look steadily at a red wafer stuck on a sheet of white paper, and after a time turn the eye to the white paper, what do you see, and why?

17. What is meant by complementary colours?

18. What is colour-blindness, and by what may it probably be caused?

19. What is meant by a phosphene, and how may it be produced?

20. What part of the retina is it which is affected by light, and what are the facts with regard to the blind spot and the yellow spot which prove that the layer of rods and cones, and not the nervous fibres, is the part influenced by light?

21. What conclusive experiment may be made to prove that the layer of cones and rods is the part which is influenced by light?

22. What appears to be the use of the cones as parts of the organ of sight?

23. What is light conceived to be?

24. What is the spot on a screen called at which a distinct inverted image of the flame of a candle may be seen, produced by its light passing through a double convex lens?

25. What is the effect of bringing the candle nearer to the lens?

26. How can the indistinctness of the image be removed, the candle remaining in its new position?

27. Has a more or a less convex lens the shorter focus?

28. Describe the parts of a camera obscura.

29. How might a similar camera be made, filled with water, so as to resemble in a general way the structure of the eye?

30. Besides the eyeball itself, what surrounding parts are necessary to the organ of vision?

31. What is the outer case or coat of the eyeball called?

32. What is the cornea?

33. What are the fluids which fill the corneal and the sclerotic chambers called?

34. What separates the aqueous and vitreous humours?

35. What is the form and structure of the crystalline lens?

36. By what is it kept in its place?

37. Describe the choroid coat.

38. Of what do the ciliary processes consist?

39. Describe the structure and mode of action of the iris.

40. What and where is the ciliary muscle, and what is the effect of its action?

41. What is the situation of the iris in the eye?

42. Compare the parts of the eye with those of an ordinary camera obscura, and explain the mode of action and the use of the iris.

43. How is the focus of the eye adjusted to near and to distant objects?

44. What simple experiment will show you that the eye is adjusted to every different distance of objects which are clearly seen?

45. What fact with regard to adjustment is proved by observations made on the living eye with the help of the flame of a taper, and how do the observations show that this is the case?

46. What three proposed explanations of the process by which adjustment is effected are excluded by the results of these observations?

47. What appears to be the most likely explanation of the changes in the degree of convexity of the front of the crystalline lens?

48. What condition of the eye exists in short-sighted persons; and whether are old or young people more subject to it?

49. What kind of spectacle-glasses correct the defect?

50. What change generally takes place in the eye as age draws on; what is its effect on the sight, and what kind of spectacle-glasses provide a remedy?

51. How many muscles move the eyeball, and what are their names and positions?

52. In what directions do these different muscles respectively turn the eye?

53. Of what different structures are the eyelids composed?

54. What is the delicate lining of the eyelids,

which also passes over the front of the eye, called?

55. What is the position of the lachrymal gland, and what is its use?

56. What provision is made for carrying off the watery secretion of the lachrymal gland after it has bathed the eye?

LESSON X.

THE COALESCENCE OF SENSATIONS WITH ONE ANOTHER, AND WITH OTHER STATES OF CONSCIOUSNESS.

1. How are purely simple sensations produced?
2. Mention some sensations which are simple in their character.
3. Of what are most of our sensations compounded?
4. Which of our sensations is least complicated by accessories?
5. Enumerate the impressions which unite to produce the complex state of feeling, giving the sensation of a hard flat surface outside oneself, caused by simply drawing the finger along the table, the eyes being shut.
6. By what modification of this experiment can you further prove that we unconsciously mix up judgments with sensations, which at first sight appear to us to be simple?
7. Mention a still more striking example of the tenacity with which we adhere to the conception that what are really complex judgments are pure sensations.

8. Explain the cause of the deception when a marble is placed between the crossed index and middle fingers.

9. In delusions of this kind, what is in fault?

10. What name is given to delusions caused by unusual conditions of the body?

11. Instead of saying I felt, or heard, or saw a thing, what would be the more cautious and true form of expression?

12. Give examples of subjective sensations referred to the senses of touch, smell, and taste.

13. What are subjective sensations affecting the ear called, and what are their more ordinary forms?

14. In what disease especially are illusive visions of great distinctness experienced?

15. How do you account for the fact that auditory and visual spectra have often been believed to be supernatural outward appearances?

16. State the illusions to which Mrs. A—— was subjected in the order of their occurrence, and explain the two methods she adopted to substantiate her belief that they were nothing more than subjective sensations.

17. Mention a remarkable case in which, by artificially combined sensations and suggestions of ideas, any number of people may, at the same time, be subjected to the same delusions of judgment.

18. What is the optic axis?

19. Why is it that the phosphene, created by pressure on one side of the eyeball, is referred to the opposite side?

20. How do you explain the fact that, although all pictures of external objects are inverted on the retina, we see them upright?

21. State an experiment which will cause a single

small object to appear double, and explain the reason of the appearance.

22. How do you explain the fact that a good painting may convey the impression that the objects represented are really present before the eye?

23. What is the effect of looking at near objects through a very small hole?

24. What kind of lens has the same effect?

25. Why do the sun and moon near the horizon look larger than when high up in the sky?

26. State an experiment with a half-crown, a convex lens and a pin, which proves that the impression received by the mind that the figure on the half-crown is raised or is depressed, is purely a matter of judgment.

27. Explain the principle of the Thaumatrope.

28. How do you account for the fact that an object appears single when viewed with both eyes, and when two images of it are necessarily formed?

29. What is the result when the eyes cannot be made to converge equally towards the object viewed, as in squinting?

30. What is the Pseudoscope, and how does it cause a stationary object to appear to approach or to recede from the eye?

31. Explain the principle of the Stereoscope.

32. Compare the impressions received by the two eyes in viewing a solid body, with those received by the finger and thumb when holding a marble.

LESSON XI.

THE NERVOUS SYSTEM AND INNERVATION.

1. WHAT three parts constitute the greater portion of the cerebro-spinal Nervous System?
2. What is the function of the nervous system called?
3. What two sets of nerves and nerve-centres together constitute the nervous apparatus of the body?
4. Describe the general character and arrangement of the sympathetic system.
5. Of what is the cerebro-spinal axis composed?
6. Where is it situated?
7. What name is given to the membrane lining the cavity of the skull and vertebral column, and what is its nature?
8. What is the name of the tissue immediately investing the brain and spinal cord, and what is its character?
9. What membrane is placed between the dura mater and pia mater, and what are its nature and contents?
10. What difference is observed between the arachnoid sac of the brain and that of the spinal cord?

11. How far downwards in the vertebral canal does the spinal cord extend?

12. How is the spinal cord longitudinally divided in front and behind?

13. By what are the two almost severed lateral halves of the cord united?

14. By what is the surface of each half of the cord longitudinally divided into three equal parts?

15. By what names are the two sets of roots distinguished?

16. How are the trunks of the spinal nerves formed, and what is the peculiarity of the posterior bundles?

17. What are the openings in the vertebral canal through which the spinal nerves pass out, and where are these openings situated?

18. How many pairs of spinal nerves are there?

19. On examining a transverse section of the spinal cord, what different colours are observed in its substance, and what is the situation of each part so distinguished?

20. What is the form of the section of the grey substance in each lateral half of the cord, and what names are applied to parts of it?

21. What relations have the fibres of the spinal nerves with the two cornua of the grey substance?

22. What happens when the trunk of a spinal nerve is irritated, and what is shown by this experiment?

23. What effect is produced by irritating the anterior bundle of root-fibres of a spinal nerve?

24. What effect is produced by irritating the posterior bundle?

25. What conclusion is arrived at from these

experiments, and what names are consequently given to the anterior and posterior roots respectively?

26. What is the result when the anterior roots of a spinal nerve of a living animal are cut through?

27. What is the result of a similar operation on the posterior roots of a spinal nerve?

28. What is said to be the state of the muscles when their nerves are incapable of exciting voluntary movement in them?

29. When a spinal nerve has been completely severed from the cord by division of its two roots, what result follows irritation of it at the cut end of the anterior root?

30. In the same case, what happens when it is irritated at the cut end of the posterior root?

31. What is the effect of irritation of that part of the posterior root which is still in connexion with the cord?

32. What is the effect of irritation of that part of the anterior root which is in connexion with the cord?

33. How do you explain the facts that in this case, and in the case of irritation of the cut posterior root which is still continuous with the nerve, no results are apparent?

34. What is the cause of that state of a limb in which we say it is "gone to sleep"?

35. What is meant by the term "nervous continuity" as applied to a nerve?

36. What are motor and sensory nerves respectively called, in consequence of their function of carrying impulses from or to the central organ?

37. How can it be demonstrated that there is a close relation between the force proper to nervous matter, and the ordinary force of electricity?

38. What is the effect upon the lower parts of the body, if the spinal cord is divided about the middle of the back?

39. When the cord is thus divided, what will happen if the cut surface of the lower part is irritated?

40. What will be the result if irritation be applied to the skin of the lower parts of the body supplied by nerves from that part of the cord which is below the cut?

41. If the cord be divided a second time below the first section, what efferent nerves are affected when the afferent nerves of one or of the other of the two detached portions of cord are irritated; and what does this show?

42. What name is given to the power which the cord possesses of converting afferent into efferent impulses, and in what part does it reside?

43. How can you show that the spinal cord, though in part a mere transmitter of impressions to and from the brain, is also an independent nervous centre, capable of originating combined movements?

44. How can you show that the function of the white matter of the anterior part of the cord is the transmission of voluntary impulses from the brain to the muscles?

45. How is it proved that the afferent impulses, which excite pain on reaching the brain, are conveyed through the grey matter of the cord?

46. How can you show that the afferent impulses cross from one side of the cord to the other on their way to the brain, but efferent impulses travel down that side of the cord by which they pass out?

47. What is the special name given to the grey

matter of the upper part of the cord, and what is its function?

48. What is the hindermost part of the brain called, and what is its relation to the spinal cord?

49. What is the fourth ventricle?

50. What part of the brain is immediately above the fourth ventricle?

51. Describe the pons Varolii.

52. What are the crura cerebri?

53. What are the four hemispherical elevations which lie above the crura cerebri called?

54. Describe the third ventricle; its position and boundaries.

55. Where and what are the lateral ventricles?

56. What parts form the floor of the lateral ventricles?

57. What and where is the corpus callosum?

58. Describe the appearance of the surface of the cerebral hemispheres.

59. What is the larger fissure called which separates the anterior from the middle portion of each hemisphere?

60. What is the relative position of the grey and white nervous matter in the cerebrum and cerebellum, the medulla oblongata, and the optic thalami and corpora striata, respectively?

61. How many pairs of nerves are given off from the brain?

62. What pairs of nerves go to the eyeball and its muscles?

63. Which pair go to the external recti muscles?

64. What are the special characters of the fifth pair, and to what parts are they distributed?

65. What is the distribution and consequent name of the seventh nerve?

66. Which pair are the auditory nerves; and what name has been given them, taking them to be a part of the seventh pair?

67. Enumerate the remaining pairs, with their special names and distribution.

68. What characters distinguish the olfactory and optic nerves from the other cerebral nerves?

69. What is the functional result of simple puncture of one side of the floor of the fourth ventricle?

70. What is the effect on an animal of extensive injury to the medulla oblongata?

71. In case of injury above the lower part of the medulla to the fibres which convey motor impulses from the brain, why is it that the muscles are paralysed on the side of the body opposite to the seat of the injury?

72. If injury of the medulla involve the origin of the left facial nerve, and the volitional motor fibres going to the cord on the same side, which sides of the face and of the body will have the muscles paralysed, and why?

73. What functions are attributed to the cerebral hemispheres?

74. Is there any satisfactory proof that particular parts of the cerebral hemispheres have particular kinds of mental faculty allotted to them?

75. Give examples of reflex action effected through the brain.

76. In what case of reflex action does a single afferent cerebral nerve give rise to an impulse affecting almost all the motor nerves of the body?

77. Explain the nature of the various muscular acts involved in reading aloud.

78. What is meant by artificial reflex action?

79. What bearing has it upon education, whether intellectual or moral?

80. Describe the sympathetic system, and state to what parts its nerves are distributed.

81. What is the probable function of the ganglia?

LESSON XII.

HISTOLOGY; OR, THE MINUTE STRUCTURE OF THE TISSUES.

1. WHAT is the examination of the ultimate structure of the tissues of the body by the help of the microscope called?

2. What is the appearance of the original material composing the first rudiment of the human body?

3. Describe the process by which this takes on the cellular form.

4. In what part do the chemical and structural changes take place which give rise to the distinguishing peculiarities of the different completely-formed tissues?

5. Describe the structure and mode of growth of the epidermis.

6. What difference is there in character between the epithelium of the mouth and of the intestine?

7. What is the character of the epithelial cells of the gastric glands?

8. What is the peculiarity of ciliated epithelium?

9. Of what is nail composed?

10. Describe the bed of the nail, and the mode of growth of the nail.

11. Of what is hair composed?

12. Describe the parts from which a hair grows, and the mode of its formation and increase.

13. What happens when a hair has attained the full length which is natural to it?

14. What parts may be distinguished in a hair of the head?

15. What provision is made at the root of each hair to keep it in good condition?

16. What is it that causes the hair to stand on end when a person is seized with fright?

17. What is the origin of the fibres which compose the crystalline lens?

18. What is the nature and structure of cartilage?

19. What is connective tissue, and what are its characters?

20. What elements are brought into view when it is acted on by strong acetic acid?

21. Whence do these two elements originate?

22. What is the structure of ligaments and tendons?

23. What is fibro-cartilage?

24. Describe a fat-cell.

25. Where are fat-cells always found in the body?

26. When developed among the fibres of the connective tissue, what do they denote, and what may be considered their use?

27. What are pigment cells, and where are they found?

28. Of what is bone formed, and what is its microscopic appearance?

29. Explain the nature of the lacunæ.

30. What are the Haversian canals, and what do they contain?

31. What is marrow, and where is it found?

32. What is the arrangement of the lacunæ around a Haversian canal?

33. Describe the manner in which ossification takes place in cartilage or connective tissue which is being converted into bone?

34. At what parts of a bone does growth take place?

35. What difference in the mode of growth of a long bone is observed between its increase in length and its increase in thickness?

36. What are centres of ossification?

37. To what structure of the body do the teeth bear the nearest resemblance, and what portion of them has exactly the same structure?

38. What two tissues form the chief part of the teeth?

39. Into what parts may a tooth, taken as a whole, be divided, and what are the position and use of each part?

40. Where is the pulp cavity of a tooth, and what is contained in it?

41. Which of the three hard tissues of the tooth forms the chief part of its substance?

42. What is the structure of dentine, and in what does it differ from bone?

43. What part of a tooth is composed of enamel, and what is the structure and character of this tissue?

44. Where is the cement found, and in what particular does it differ from true bone?

45. Describe the development of the teeth from their earliest appearance.

46. What is the number of the deciduous or milk set of teeth, and what are the ages at which

the cutting of these teeth commences and is completed?

47. How many kinds of teeth are there in this set, what are they called, and how many are there of each kind?

48. Describe the development of the permanent set of teeth.

49. What are the teeth called which replace the milk molars, and what is their character?

50. How many teeth are there in the complete permanent set, and what teeth are added to those corresponding with the first set to make up the number?

51. Which tooth of the permanent set is the first to be cut, and at what age does it appear?

52. Which tooth is the last to appear, at what age is it cut, and what is it called?

53. What two kinds of muscle are there?

54. What muscles of the body are composed of striated fibres, and what are the sheaths called in which these muscles are enclosed?

55. What is the sheath called which envelopes each individual fibre of a muscle, and what are its physical qualities?

56. What is the microscopic appearance of a striated muscular fibre?

57. In what two ways will a fibre break up when its sarcolemma is torn?

58. What is the character of the muscular fibres of the heart?

59. What are the microscopic characters of the fibres of smooth muscle?

60. Of what two elements does nerve tissue consist?

61. What is the microscopic appearance of ordi-

nary nerve fibre during life, and what changes does it undergo shortly after death?

62. What is the neurilemma?

63. What is the arrangement and character of nerve fibres when they enter the central organs, or approach their peripheral terminations?

64. What are tactile corpuscles?

65. With what are the fine ends of the nerves in many cases continuous in the brain and spinal cord?

66. What is the character of the fibres of the olfactory nerves?

67. Where are ganglionic corpuscles found, and what are their characters?

ANATOMICAL AND PHYSIOLOGICAL CONSTANTS.

1. WHAT is the average weight of a man?

1. GENERAL STATISTICS.

2. How much of this weight will belong to muscles, skeleton, skin, fat, brain, thoracic viscera, and abdominal viscera respectively?

3. What additional weight must be allowed for the blood?

4. What proportion of the whole body-weight consists of blood?

5. What is the weight of water, and what of solids, which together form the body?

6. Of what elementary substances are the solids composed?

7. Under what four heads may the compounds they form be arranged?

8. What weight of matters of all kinds does the body lose in twenty-four hours; and of this weight how much is water, how much is carbon, how much nitrogen, and how much minerals?

9. What quantity of heat does the body part with in twenty-four hours?

10. What is meant by a foot-ton?

11. What weight of water is lost in twenty-four hours by the lungs, kidneys, skin, and fæces?

12. What weight of other matter?

13. What weight of nitrogen is lost by the kidneys, skin, and fæces respectively?

14. What weight of carbon is lost in twenty-four hours by the lungs, kidneys, skin, and fæces?

15. What weights of solid dry food, of oxygen, and of water, are gained by the body in twenty-four hours, to balance the loss?

2. Digestion.

16. What weight of carbon and what of nitrogen will the body require for daily food?

17. By what quantities of proteids, amyloids, fats, minerals, and water, will these and the other necessary elements be most conveniently furnished?

18. What articles of food, and in what quantities, will represent the same proportions of those ingredients?

19. What will be the whole weight of fæces passed per diem, and how much of this is solid matter?

3. Circulation.

20. How many times a minute does the heart beat, and what volume and weight of blood does it probably drive out at each stroke from each ventricle?

21. At what rate will the blood probably move in the great arteries, and in the capillaries?

22. What would probably be the time taken up by the blood in performing the entire circuit?

23. What would probably be the pressure exerted by the left ventricle on the aorta?

24. What amount of work in foot-tons will be done by the left ventricle in twenty-four hours?

25. What will be the work of the whole heart in the same time, represented in foot-tons?

4. Respiration.

26. How many respirations are taken in a minute?

27. What is the vital capacity of the chest, and what are the names and quantities of the successive portions of air which make up the whole amount?

28. How many cubic feet of air would pass through the lungs in twenty-four hours?

29. In passing through the lungs, what proportion of oxygen does it lose, and what proportion of carbonic acid does it gain?

30. During the twenty-four hours, what weight of oxygen is consumed, and what weight of carbonic acid is produced?

31. With what weight of carbon does this weigh of carbonic acid correspond?

32. What weight of water is exhaled by the lungs in twenty-four hours?

33. What are the proportions of carbonic acid in the atmosphere, and in expired air?

34. How many cubic feet of ordinary air will be required per diem, in order that it may not be vitiated to a greater extent than one per one thousand of carbonic acid?

35. How many cubic feet of well-ventilated space should a man have for his respiration?

5. Cutaneous Excretion.

36. What quantities of water, of solid matters, and of carbonic acid will be thrown off by the skin in twenty-four hours?

6. Renal Excretion.

37. What weight of water, of urea, and of other solid matters, will be passed by the kidneys in twenty-four hours?

7. Nervous System.

38. At what speed does a nervous impulse travel in a frog?

39. In man, what are the results of different calculations as to the speed of a nervous impulse?

8. Histology.

40. What is the size of a red, and what of a white blood-corpuscle?

41. What is the breadth of a striated muscular fibre?

42. What is the breadth of a plain muscular fibre?

43. What is the breadth of nerve fibres?

44. What is the breadth of the fibrils of connective tissue?

45. What is the size of scales of the epidermis?

46. What is the breadth of capillary blood-vessels?

47. What is the length of cilia from the wind-pipe?

48. What is the breadth of the cones in the "yellow spot" of the retina?

THE END.

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